PROBLEMS OF AUTOMATION AND MECHANIZATION

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MACHINE MOLDING OF PORCELAIN PIN INSULATORS

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A new method for molding porcelain pin insulators used as insulation for cables of low-voltage power lines is suggested. A machine for molding TF-20 insulators is described. A set of technological equipment for mini-production units of low and medium capacity is presented. The technical parameters of the set of machinery are given.

According to experts, insulators are currently among the most common ceramic products. Testimony to this is the constant growth in insulator production volume. However, the quality of insulators still leaves much to be desired. The authors of the present paper suggest a new method for molding porcelain pin insulators (Fig. 1) intended for insulation of cables of low-voltage power lines. The method is based on contemporary technologies that involve mechanized and automated molding of the pin intermediate product and prevent structural deformation, cracking, warping, etc.

The Slavyanskii Institute of Ceramic Machine Building has developed a machine for molding pin insulators (USSR Inventor's Certificate 1253812) that makes it possible to implement this method with account for the specific structural and mechanical properties of finely disperse plastic porcelain mixtures with a high quartz content. Molding is performed in separable steel molds by a combined steel punch. The working surface of the punch is relieved, and all similar points of the relieving are located in the same plane inclined toward the direction of rotation of the molded article at an angle of 35° (USSR Inventor's Certif. 472007). Use of this method makes it possible to ensure optimum conditions for flow of the porcelain mixture and decrease the molding force, i.e., develop the most favorable conditions for machine molding and output of high-quality articles.

The machine, whose kinematic scheme is shown in Fig. 2, is designed for molding TF-20 porcelain insulators and contains a multipositional rotary table *2* made in the form of a polygonal drum and rotated in vertical plane on shaft *1* and containing composite molds consisting of an outer barrel *3* that is rigidly fastened to the table, a spring-loaded middle barrel *4*, and a spring-loaded base *5*. In addition, shaft *1* carries a Maltese cross *6* that includes a carrier *7* fitted to the exit end of the shaft of a drive *8* and is fixed co-

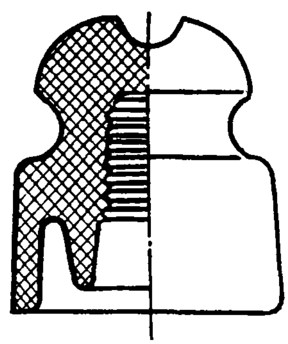

Fig. 1. Porcelain pin insulator.

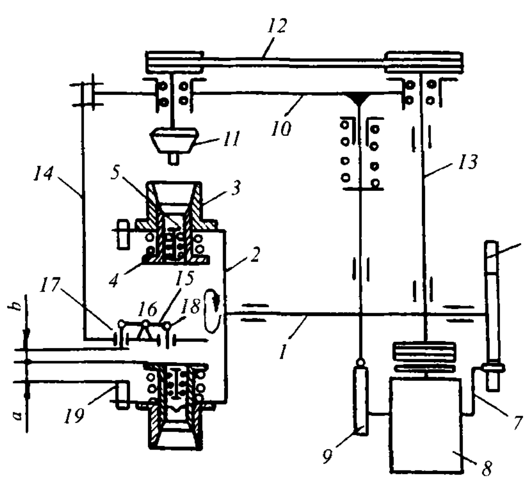

Fig. 2. Kinematic scheme of the machine.

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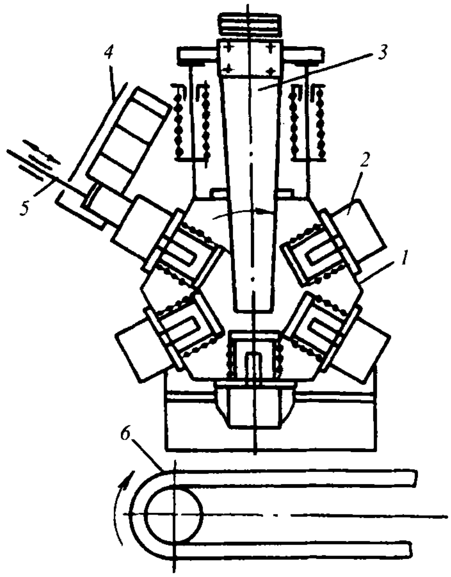

Fig. 3. Mold charging mechanism: *1*) rotary table; *2*) outer barrel; *3*) ejector for molded pieces; *4*) slanted chute; *5*) pusher; *6*) belt conveyer.

axially to the table. On the other end of the drive shaft, a cam *9* is fixed, which carries a spring-loaded cross-piece *10* with a molding punch *11* that is connected by a wedge-belt transmission *12* to the vertical shaft *13* of the drive . The cross-piece also carries an ejector *14* for molded pieces that contains a transmitting mechanism consisting of a bell-crank *15* with a hinged support *16* and pushers *17* and *18*. Next to each mold, a fixed stop *19* is installed whose height and, accordingly, distance to the inner level of the mold a and to the ejector bottom $a + b$ can be varied.

The mold charging mechanism (Fig. 3) is designed as a slanted chute with a pusher meant for compressing the intermediate piece in the mold. The unit includes a belt conveyer with a separate drive for receiving and transporting the molded articles.

The machine operates as follows: being switched on, the drive rotates the horizontal shaft with the carrier and the cam and the vertical shaft, which rotates the molding punch by means of the wedge-belt transmission. The carrier cog periodically enters the Maltese-cross slots. The Maltese cross, through periodic rotations, imparts discrete movements to the multipositional table. The spring-loaded cross-piece together with the punch, the ejector, and the belt transmission fixed to it rests on the working surface of the cam and moves reciprocally up and down. The moment the table stops, an intermediate piece is inserted into the opposite mold by the pusher and compressed. At the next turn of the table the mold with the compressed piece inside is placed under the rotating punch, and the next mold is placed opposite the next intermediate piece. The punch, by descending and rotating, molds the inner configuration of the insulator, and the outer shape of the insulator is molded by the inner surface of the composite mold. At the next turn of the table, the molded pieces are ejected from the molds to the belt conveyer.

In order to preserve the geometric dimensions and configuration of the molded insulator, its ejection from the mold is carried out as follows.

As the cross-piece descends, the ejector rigidly fastened to it (Fig. 4*a*) moves downward as well and makes contact with the middle barrel *1*, and next it moves together with the base *2* along the pathway a and separates the insulator from the conjugate surface of the outer barrel *3*. In further motion, the transmission mechanism encounters on its path the fixed stop *4*, and using the pusher *5* it turns the lever *7* on the support *6*, which, in turn, uses the other pusher *8* to act upon the base and separates the part of the insulator that is in contact with the surface of the middle barrel (Fig. 4*b*). After that the article is easily separated from the base and reaches the conveyer. In order to improve the separation conditions, the conjugate surfaces are lubricated or coated with a hydrophobic material such as fluoroplastic.

During the reverse motion of the cross-piece, the punch and the ejector move upward, the composite parts of the mold are returned by the springs to the initial position, and the molding cycle is repeated.

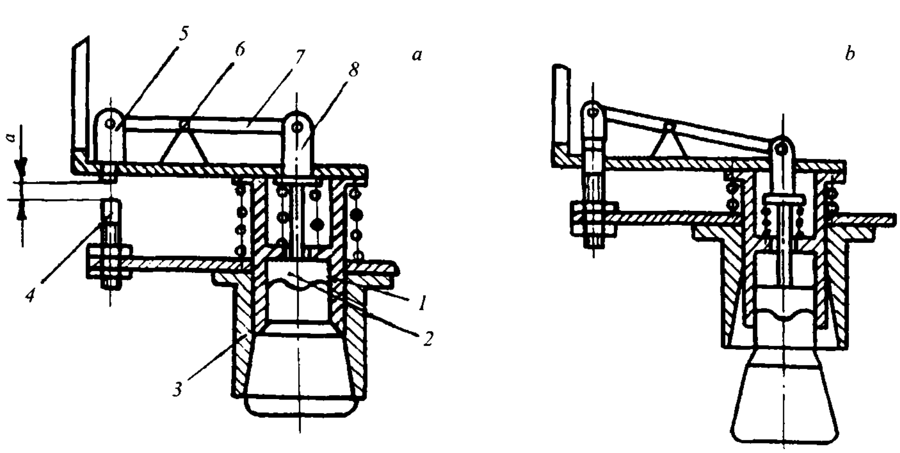

Fig. 4. Initial (*a*) and final (*b*) positions of the molded piece ejector.

The machine described served as the basis for a set of technological equipment for low and medium capacity [1] for production of TF-20 insulators that was designed, manufactured, tested, and shipped to the customer. The structural and technological scheme of this set is shown in Fig. 5. It contains vacuum press *1* for extrusion of intermediate insulator pieces 70 mm in diameter and 120 mm long made from a porcelain mixture of 18% moisture content, machine *2* for molding semifinished insulator pieces, mandrel machine *3* for straightening the outer surface of the

pieces, and drying chamber *4*. The set includes two hoppers *5* that act as interoperation containers for storage of molded and straightened semifinished insulator pieces. Intermediate pieces are stored on the standard wooden palettes *6* of size 1200 × 800 mm.

Technical Parameters of the Set of Equipment

Output, pieces/h	400
Type of molded insulator	TF-20
Size of an intermediate piece, mm:	
diameter	70
length	120
Weight of an intermediate piece, kg	1
Power, kW	3.3
Compressed-air pressure, MPa	0.5 – 0.6
Air consumption, m^3/h	1.5
Overall dimensions, mm:	
length	5800
width	3650
height	2480
Weight, kg	4200

A special feature of the set of equipment consists in the existence of mechanized attendance, which makes it possible to exclude waste of time and labor force on feeding intermediate pieces, to ensure accumulation of intermediate pieces and machined insulators, and to improve product quality through prevention of cullet, deformations, clogging, etc.

In designing the equipment special attention was paid to preserving the geometric dimensions of both the intermediate and semifinished pieces in the course of molding, straightening, and drying. The accumulating hoppers are the integral part of the equipment of the set. Their capacity is determined from the prescribed time and the maximum permissible idle time for repairs, adjustment, etc. The idle-time duration should not exceed the limit assigned for repairs (10% of the shift time period, i.e., 1 h). For operator convenience, the main technological equipment is placed 0.7 m from the machine and 1.2 m from the drying chamber and the vacuum press.

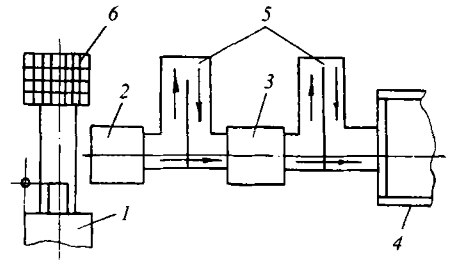

Fig. 5. Structural and technological scheme of the set of equipment for production of semifinished pieces for pin insulators.

The operations on the machine set consist of charging the vacuum press, cutting the intermediate pieces, molding the inner surface of the insulator, straightening its outer surface, and drying. The hoppers are used as needed.

The performed tests demonstrated high reliability and efficiency of all the components of the set of equipment and the possibility of using it in production of other types of pin insulators.

The Slavyanskii Institute of Ceramic Machine Building has practical experience in the design, manufacture, installation, and adjustment of technological equipment and tooling for ceramic mini-production units of various capacity.

REFERENCES

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